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FUNDAMENTALS OF MINERAL  
CONSERVATION

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## FUNDAMENTALS OF MINERAL CONSERVATION

WALTER H. VOSKUIL

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It is a concept of long standing in the study of man's economic behavior that his wants are considerably beyond his present means of satisfying them. People need food and clothing and shelter but do not limit their wants to these elemental necessities. The need for food is accompanied by a want for better food, a wider variety of choice, a more ample supply. This type of expanding want is also true of housing and clothing, but man does not stop there. He likes to travel-luxuriously perhaps; he seeks amusements, education, cultural enjoyments; he will spend a great deal of money in caring for his health or in restoring it if it is impaired. Man wants

much and can satisfy these wants only upon condition that he can produce in abundance and in a wide variety of means, and he soon learns that the use of his hands and muscles alone yields only a small return.

Production is entirely a matter of controlling the physical environment. Production means shifting things about, mixing them, heating them, cutting them, covering them with other stuff that has been shifted about, and so on, and then exchanging them for other things that in their turn have been shifted about.

Let us think for a moment of our predecessors. With an immense amount of hand labor they built irrigation projects, terraced hillsides or changed the courses of rivers to find a water supply. They developed around their projects a highly organized human society, only to find their technological environment too difficult to manage, and so to see their society decay. There were two reasons for this: first, their motive power was almost entirely unaided human effort, usually the labor of slaves; second, they did not have, in all the evidence before us, that knowledge of the properties and behavior of nature that we call science; in particular they did not seem to know how to convert thermal into kinetic energy. To us it seems a miracle that any large society could have survived without a knowledge of heat engines. It was not until the use of metals and fuels became common that one modern engine could do the work of a thousand laborers of ancient Egypt.

In addition to fuel and metals man needs other material, in large quantities, not only to make the things he uses directly, but also to build the housing and machines within which and by means of which his many wants are filled. It is the earth materials (the metals and minerals and fossil fuels imbedded in or otherwise locked in the earth's crust) which are the source materials that, when effectively used, make it possible for his hands and his intellect to be highly productive.

Until he learned how to use earth materials, man was virtually limited to feeding and clothing himself. It was only when he learned the properties of minerals and how these could be turned to his advantage in his efforts to produce things, that man learned not only to produce food supplies more easily and abundantly but had plenty of time and energy available for producing other things besides food.

The vast tonnage of minerals used is indicative of their role in

the operation of a productive society. In the United States minerals account for 50 per cent of railroad car loadings, and, if the products made from minerals are included, the tonnage easily rises to 75 per cent.

An economy based upon the effective use of minerals has given the mineral-endowed peoples of the globe not only adequate food and clothing, but also a wide range of material comforts, education, medical services, cultural advantages and leisure.

The "hard core" of the mineral development pattern is the iron ore-fuel grouping. Only a society equipped with power-driven machines can be highly productive, and only iron in its many alloyed forms is a suitable material for the machinery and equipment of a productive society.

The ferro-alloys constitute a group of metals whose primary function is to make of steel a more effective material for economic production. The principal iron alloying metals are chromium, manganese, molybdenum, nickel, titanium, tungsten, and vanadium.

The usefulness of the nonferrous metals is based upon their special properties—the electrical conductivity of copper; the durability, low melting point and electrical properties of lead; and as alloys.

The chemical and industrial minerals perform special functions as insulators, refractories, fluxes, solvents, protective coatings and processors. Ferro-alloys, nonferrous metals and chemical and industrial minerals are frequently shipped great distances and sometimes are gathered from remote quarters of the globe.

Minerals of construction are numerous because of the variety of building requirements. Minerals of construction are, in the main, obtained locally.

### THE LONG-TERM OUTLOOK

Beyond the immediate economic conditions in the mineral industries is the long-term outlook for a continued flow of mineral supplies. The heavy draft upon our mineral resources during the war and the necessity of imposing restrictions upon civilians in the free use of minerals has given rise to concern over the adequacy of our mineral supply. The period encompassing World War II and the years immediately following it may mark a turning point in mineral exploitation and utilization. The time when minerals were obtained from rich, favorably placed deposits (the high-grade ores of the Mesabi range, the enormous low-cost oil reservoir of

East Texas, the choice coking coals of strategically located Connellsville) is giving way to an era in which it will be necessary to make use of lower grade materials or less easily accessible sources for coal, petroleum, iron ore, copper, lead and zinc. Some of the more significant changes in the offing are as follows:

**Coal.** There is a foreseeable depletion of the elite type of coking coal deposits of low-ash and low-sulphur content, and thus a need for exploring the feasibility of obtaining metallurgical coke from hitherto non-coking coals.

**Petroleum.** The trend has been definitely toward deeper horizons in new drilling, more extended efforts in secondary recovery in old fields, the commercial development of synthetic processes for making liquid fuel out of natural gas, and a distinct possibility that this process may be applied to coal.

**Iron ore.** The life of the high-grade iron ore supplies in the Lake Superior district is now recognized as limited in duration; and, in anticipation of depletion, alternative sources of ore must be sought. Potentially these are obtainable from the vast tonnages of low-grade ore in the Superior district, or from high-grade ore deposits in Canada, Cuba, Venezuela, Brazil, Sweden, Sierra Leone, Labrador and Chile. Clearly, the steel industry and the nation are faced with the necessity of formulating a policy with respect to ore development—a policy which can effect far-reaching changes in the geographical pattern of the American steel industry.

#### DEPLETION OF RESERVES

The depletion of certain favorably located and high-grade mineral deposits has given rise to a fear of mineral shortage and has tended to obscure the essential nature of mineral resources.

The limiting factor in estimates of mineral resources has been the concept of mineral reserves as known measurable ore bodies, the depletion of which was equivalent to mineral exhaustion. This concept is being replaced by the concept that the elite ores which gave rise to the mining industry and carried it thru its first stages are but a small part of the total reserve; that the reserves of ore of less than elite quality, of mediocre and low rank, are many times the volume of the choice ore bodies. Advances in mineral technology or changes in price bring larger volumes of material into the realm of commercial ore. To maintain a continuous flow of mineral from these lower-rank ores without an undue rise in price is a major problem of mineral technology.

## A PROGRAM OF CONSERVATION

Altho the draft upon our mineral supplies is heavy and may increase in the future, we must not assume that mineral exhaustion is imminent. However, we shall find it necessary to proceed along constructive lines in the economical and efficient use of our mineral supply.

There are three clearly indicated steps necessary to maintain a steady flow of minerals, two of which are the direct concern of the conservationist and the third, altho not augmenting or conserving the original resource itself, has a conservational consequence by increasing the efficiency of resource utilization. These three steps are:

1. The reduction of loss and waste in present mining practices.
2. A program of ore discovery, including discovery and measurement of "sub-ore."
3. A program of technological improvement thru research for greater efficiency of resource utilization.

First in the program of mineral conservation is the reduction of loss and waste. A large part of our mineral production in coal, in oil, in iron ore, to mention only the three leading mineral materials of industry, comes from high-rank favorably located deposits. The factor of low-cost production together with the factor of low-cost assembly of these important materials into the centers of processing and manufacture forms the basis of our highly productive industrial economy. The low-cost deposits of minerals represent only a small part of our total mineral reserve. Nevertheless, at present, mining is concentrated on the richest and most accessible deposits and they are being exhausted at a rate which forecasts an early dependence upon leaner and less accessible ores. We must simply recognize this form of mineral exhaustion and, knowing this to be the case, develop the means by which mineral flow can be maintained from low-grade and less accessible deposits.

In the meantime, the advantages of low-cost production can be extended if every effort is made to mine these beds or ores with a minimum of waste and loss. This is a problem of mining technology and of economics—price and competitive relationships among mining districts. We can, in this discussion, merely indicate the location of the problem and its relationship in prolonging the life of low-cost reserves.

The second cornerstone in mineral conservation is a continued

program of mineral discovery. This program has been successful in the petroleum industry up to the present, altho there are signs that discoveries of the magnitude required for present-day oil consumption are becoming more difficult to find. With waning discovery of mineral outcrops, search must be directed to the less obvious deposits, of which vast numbers must be hidden by the ubiquitous overburden. Every skill of geology must be employed to this end.

The third requirement in mineral conservation is technology. Technology has been termed the "multiplier of our natural resources"; it is the science of technique and includes all innovations in production and trade brought about by science, invention and scientific management. Technology created and is continually transforming modern industrialism; it causes changes and adjustments in our economic, political and social order.

Applied to the utilization of mineral resources, technology is probably the most important factor in extending the life of mineral reserves. It does not, in any way, invalidate the need for the two steps described above. Technology, in itself, is of no avail unless the mineral raw materials are there to be produced. Because there are innumerable ways in which technology aids in increasing mineral production and the usefulness of a mineral after it is mined, we may truly say "technology is a multiplier of mineral resources."

Technological change and improvement in the mineral industry begins with the technique of exploration. The search for mineral deposits, which was originally the adventurous efforts of an individual prospector, is now a project which requires the services of the geologist, geophysicist and geochemist. Closely associated with discovery is the technique of mineral recovery. Technological advances in mining practices today are effecting economies and reducing wastes so that existing mineral deposits may have their usefulness extended thru more complete recovery from the earth.

The utilization of low-grade ores in copper mining is one of the outstanding achievements of the mining industry and an example of what can be done by applying technology to the problem. In the near future, low-grade mineral-bearing deposits not now considered minable will have to be used, and technology must find a way to make these ores economically available. This is particularly true of lead and zinc.

In the realm of mineral processing and preparation, technology

has made great contributions toward expanding the effective use of minerals. The meaning of this can be most effectively demonstrated by an example in petroleum technology and the supply of motor fuel. The automobile ranks high on the list of things the average American chooses to buy, which accounts for the millions of automobiles in use in this country. The growth of automobile use since 1905 required a large quantity of crude petroleum from which gasoline is obtained. So great was the demand that the fear of a shortage of gasoline has been repeatedly expressed. In fact, a shortage of gasoline would surely have occurred if we had had to depend on the refining methods of the early days of the oil industry. This is what has happened since:

1. Original source: Straight-run refining of oil; gasoline yield was about 18 per cent of the crude oil.
2. Cracking process: Processes were developed to make more gasoline by cracking the heavier oil produced in straight-run refining; the result was that gasoline recovery went up from 18 to 50 per cent.
3. Catalytic cracking and hydrogenation: This process makes it possible to convert crude oil entirely into gasoline, but we do not yet need to go that far.
4. Coal gasification and synthesis: This makes it possible to gasify coal and build liquid fuels out of the gas or to convert natural gas into motor fuel at costs that are now almost competitive with that of producing gasoline from crude oil.

Thus technology has in this instance "multiplied" the product from a natural resource and in addition has developed means of bringing hitherto unusable materials into the class of source materials for the widely used motor fuel.

In the future the mineral industry will effect the recovery of more than one mineral product from natural ore. We note the beginning of a process for the recovering of both uranium and fluorine from phosphate rock in the course of processing for phosphatic fertilizers. We may ultimately expect to see a recovery of sulfuric acid from the pyritic by-product of coal mining and a further by-product recovery of iron oxide from this same pyrite. Blast furnace slags may be made to yield manganese. In Europe cement and sulfur are produced as joint products of the calcining of gypsum. One might speculate on the possibilities of recovering potassium, aluminum and sulfur from alunites. These developments or suggestions merely illustrate the direction in which mineral technology will proceed to a more complete recovery of useful elements and products from the raw materials of the earth.



